Effect of automated messaging on oral hygiene in adolescent orthodontic patients:
A randomized controlled trial

Mike C. Ross[a]; Phillip M. Campbell[b]; Larry P. Tadlock[c]; Reginald W. Taylor[c]; Peter H. Buschang[d]

ABSTRACT

Objective: To determine whether automated text messages sent daily to adolescent orthodontic patients improves oral hygiene more than weekly reminders.

Materials and Methods: A blinded, prospective, randomized controlled trial was designed to evaluate the effects of automated messages on oral hygiene. Subjects were recruited from patients undergoing orthodontic treatment at the Texas A&M University College of Dentistry, Department of Orthodontics. They were being treated with a variety of fixed full appliances in both arches. Subjects were randomly assigned to either a once-a-week text message group or a daily text message group. There were 52 females and 27 males who were 12 to 17 years of age. Oral hygiene was measured at the beginning of the study and again 8.6 ± 0.9 weeks later.

Results: The daily reminder group (N = 42) had significantly greater improvements in oral hygiene compliance than the weekly reminder group (N = 37). The daily score decreases were 48%, 21% and 19% for the bleeding index (BI), plaque index (PI), and gingival index (GI), respectively. The weekly score decreases were 27%, 14% and 13% for the BI, PI, and GI. There were no sex differences in hygiene changes during the study. The 42% of patients who completed the survey at the end of the study wanted more frequent messages and reported that messages related to decreasing treatment time were the most effective, while those related to oral hygiene were the least effective.

Conclusions: Daily text messages are more effective at improving oral hygiene than weekly text messages. (*Angle Orthod.* 2019;89:262–267.)

KEY WORDS: Automated messages; Adolescents; Oral hygiene; RCT

INTRODUCTION

Ideal treatment outcomes depend on the orthodontist's ability to maintain optimum levels of compliance.[1–3] It is particularly important for patients to be compliant with respect to oral hygiene. Oral hygiene typically declines in patients with full-fixed appliances due to difficulties associated with brushing and flossing.[4–8] Adhesively bonded, fixed orthodontic appliances often make brushing and maintaining good oral hygiene difficult, leading to increased gingivitis, poor oral hygiene, and increased risk of developing white spot lesions.[5] Compliance is particularly important for teenagers, who are the patients most commonly treated in orthodontics.[4]

Text messaging, which has become the primary mode of communication for adolescents,[9] provides a means of increasing compliance. Bowen et al. followed patients for 2 months and found that automated weekly text reminders were effective in improving oral hygiene.[10] A randomized controlled trial showed that the bleeding, gingival, and plaque indices all improved in patients receiving weekly text messages for 5.4 months.[11]

Although automated messaging systems increase patient compliance, it remains unclear how frequent the messages need to be to optimally affect patient compliance during orthodontic treatment. The medical

[a] Private Practice, Amarillo, TX, USA.

[b] Professor Emeritus, Department of Orthodontics, Texas A&M University College of Dentistry, Dallas, TX, USA.

[c] Associate Professor, Department of Orthodontics, Texas A&M University College of Dentistry, Dallas, TX, USA.

[d] Regents Professor and Director of Orthodontic Research, Department of Orthodontics, Texas A&M University College of Dentistry, Dallas, TX, USA.

Corresponding author: Peter H. Buschang, PhD, Orthodontic Department, Texas A&M University College of Dentistry, Dallas, TX 75246, USA
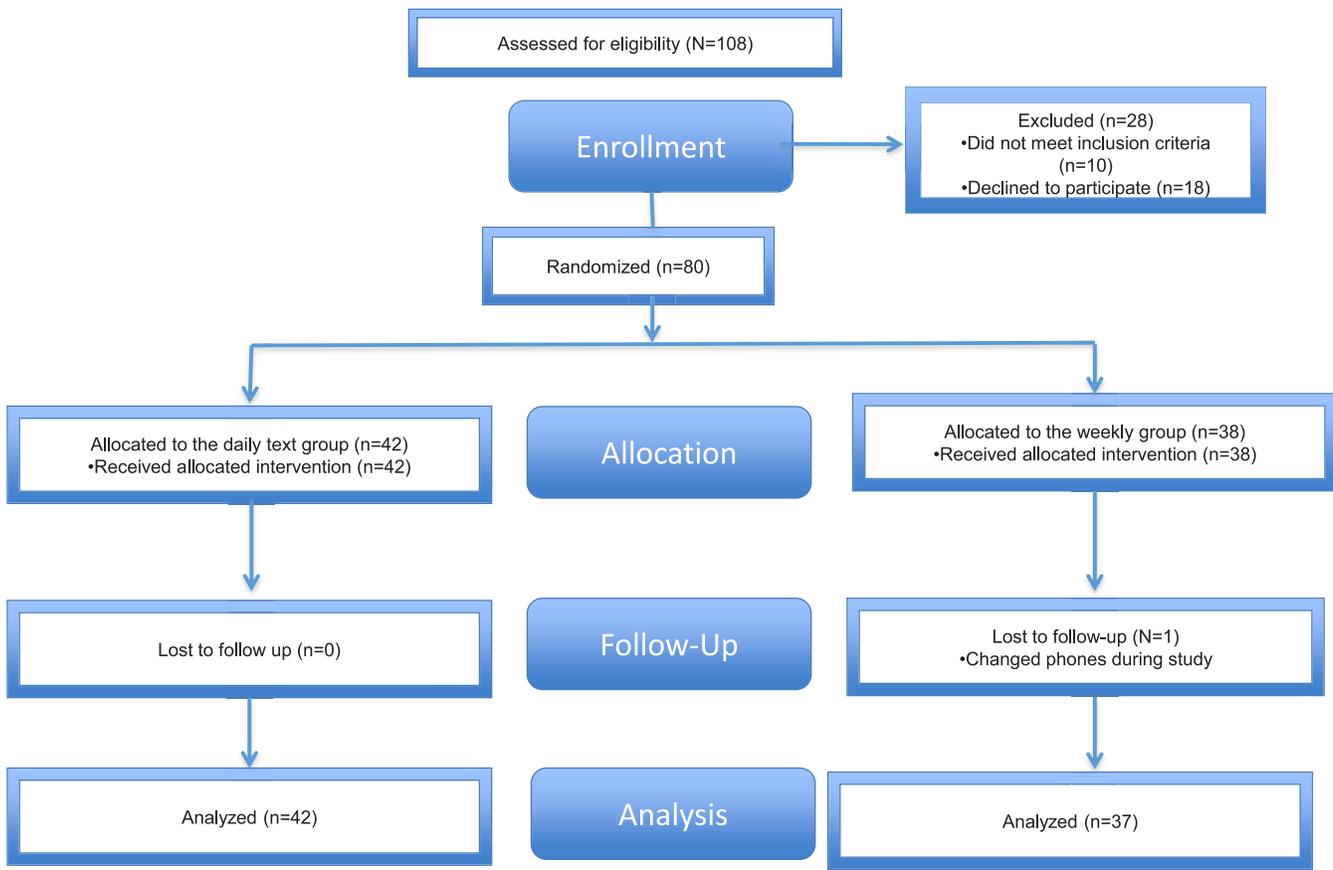(e-mail: phbuschang@tamhsc.edu)

Figure 1. Diagram of patient flow through the study.

literature shows that increasing the frequency of automated messages increases compliance.[12–15] Sending multiple text messages improves attendance and reduces no shows across healthcare settings,[14] improves adherence during treatment,[15] and increases compliance.[13] Triggering patients with repeated messages relies on the human behavior model to produce a desired response.[16]

The objective of the present study was to determine whether and how the frequency of repeated messages affects patient compliance. The null hypothesis was that there are no differences in the hygiene changes that occur in orthodontic patients who receive either daily or weekly text message reminders to brush their teeth.

MATERIALS AND METHODS

Subjects

A parallel, blinded, randomized controlled trial was performed to evaluate the effects of automated messages on oral hygiene. Patients were recruited from those undergoing orthodontic treatment at the Texas A&M University College of Dentistry. They were being treated with a variety of fixed full appliances in both arches. The study was approved by Texas A&M University IRB (approval # 2105-0532-COD-Ext). Parents/patients signed informed consent forms to enroll their child in the study and approved the use of direct messages sent to the child.

Power analyses were performed to determine sample size requirements using reported estimates of variation.[10,11] Based on an alpha error of 5%, a beta error of 5%, and an effect size of 0.5, it was estimated that 27 patients were needed per group. Due to potential nonparticipation and dropouts, a total of 80 patients were recruited (Figure 1). To be eligible for the study, patients had to be between the ages of 12 and 17, have had no significant medical history, have been in upper and lower braces for at least 4 weeks, and be able to operate a cellular device with text messaging services. Patients were excluded if they could not speak/read English fluently, had to spend more than an hour driving to their appointments, and were going to complete their treatment within 6 months (most of the patients completed treatment approximately 1 year after starting the study). There were no changes to the methods or outcomes after the trial started.

Protocol

Patients were recruited between October 2015 and September 2016; recruitment ended after 80 subjects had been enrolled. There were 52 females and 27 males who participated in the study. Simple randomization was used to assign each of the subjects to either the weekly text message group (24 females, 13 males) or daily text message group (28 females, 14 males). Sampling was performed by using Microsoft Excel (Microsoft, Redmond, WA). One subject dropped out. Automated messages were sent using Orthodontext (Coppell, Texas) automated messaging software. Only the company sending the automated messages knew the patients' group assignments. The examiner did not communicate with the patients about text messages during the course of the study.

There were three different types of text messages sent: oral hygiene texts, shorter treatment time texts, and motivational texts. Different texts were sent to determine their relative effectiveness. The oral hygiene texts included: (1) "Don't forget to brush your teeth twice a day!" (2) "Make sure to brush your teeth for at least two minutes!" (3) "Floss your teeth before you go to sleep and remember to hug the teeth with the floss!" (4) "Remember to use mouth rinses when you brush and floss to help the teeth stay extra clean!" Shorter treatment time texts included: (5) "If you want your braces off faster…be sure to keep your mouth super clean!" (6) "Your time in braces will be shorter if you keep your mouth very clean!" The motivational texts included: (7) "Research shows that a better smile leads to better-paying jobs." (8) "Keep taking good care of your teeth and you're going to have a great smile!" Text messages were always sent at the same time, depending on when they best fit into the parents'/patients' schedules. At the start of the project, all subjects received oral hygiene instructions from a standardized video (www.youtube.com/watch?v=GtSi2IcfynE) produced by Bracesquestions.com on brushing and flossing; they also received an oral hygiene kit.

Follow-up

Patients in daily and weekly reminder groups were followed for 8.6 ± 1.0 and 8.5 ± 0.7 weeks, respectively. The primary outcome variable was change in oral hygiene, measured by the bleeding, plaque, and gingival indices. The three measures were taken on two occasions, T1 (baseline) and T2 (final). These time periods were chosen because previous studies used weekly time intervals.[10,11,17] Ramfjord teeth (maxillary right first molar, maxillary left central incisor, maxillary left first premolar, mandibular left first molar, mandibular right central incisor, and mandibular right first premolar) were used for the periodontal tests.[11] One blinded examiner gave all of the oral

Table 1. Number of Sites Detected at Initial (0) and Final (1) for the Bleeding Index (BI), Plaque Index (PI), and Gingival Index (GI) of the Daily and Weekly Text Groups

	Daily		Weekly		
	Mean	SD	Mean	SD	Probability Difference
BI(0)	17.2	7.2	19.1	6.1	.211
BI(1)	8.9	5.9	14.0	6.7	<.001
GI(0)	9.6	1.4	10.3	2.1	.070
GI(1)	7.6	1.5	8.9	2.1	.002
PI(0)	18.1	3.3	19.7	3.4	.034
PI(1)	14.7	3.7	17.2	3.3	.002

hygiene instructions and performed the periodontal measurements. The examiners working with the patients, collecting data, and evaluating the data were blinded until the completion of the study. Using SurveyMonkey, a survey was conducted at the end of the study for qualitative analysis of compliance. All data were collected in the Department of Orthodontics at the Texas A&M University College of Dentistry.

Statistical Analyses

The skewness and kurtosis statistics showed that the data were normally distributed. Means and standard deviations were used to describe the samples. Due to an initial group difference, analyses of covariance were used to compare between group differences in the hygiene changes that occurred over time. The Cohen's d effect size was used to standardize the difference between two means in order to determine clinical significance.

RESULTS

Initial and Final Values

Initially (T1), the weekly group had higher baseline scores for all three periodontal tests, but only the plaque index showed a statistically significant between-group difference (Table 1). Based on the total number of sites for the BI (N = 108), GI (N = 24), and PI (N = 36), the daily group had positive scores for 16%, 40%, and 50% of possible sites for the BI, GI, and PI, respectively. The weekly group had positive scores for 18%, 43%, and 54% of possible sites. From T1 to T2, the daily group's scores decreased 48%, 21%, and 19% for the BI, PI, and GI, respectively. The weekly group's score decreased 27%, 14%, and 13% for the BI, PI, and GI. Between-group differences for all three indices at the final measurement occasion (T2) were statistically significant.

Daily and Weekly Changes

Analyses of covariance, controlling for the initial (T1) values, showed significantly greater improvements in

Table 2. Analyses of Covariance Comparing Daily and Weekly Changes of the Bleeding Index (BI), Plaque Index (PI), and Gingival Index (GI), Controlling for Initial Values

	Daily		Weekly		
	Mean	SE	Mean	SE	Group Difference
BI	−8.6	0.72	−4.8	0.77	<.001
PI	−3.6	0.38	−2.3	0.41	.026
GI	−2.1	0.22	−1.3	0.24	.015

hygiene in the daily than weekly text message group (Table 2). The Cohen's d statistic for the changes of the BI, PI, and GI were 0.81, 0.52, and 0.56, respectively. There were no significant sex differences for the decreases in the scores of the BI, PI, and GI in both the weekly and daily groups.

Preference for Reminders and Periodontal Correlations

A total of 70% of the patients chose nightly reminders and 30% chose morning reminders. Of those who chose morning reminders, 75% wanted the text reminder between 7:00 and 8:00 AM. Of the patients who chose nightly reminders, 70% elected to receive a text message between 7:00 and 9:00 PM.

The three periodontal tests showed low to moderate, statistically significant within-measure correlations between the initial and final measurements, explaining 21%-46% of the variation (Table 3). The between-measure correlations were substantially lower, with several of the correlations in the daily reminder group being not statistically significant.

Survey Results

The survey had a 42% response rate. A total of 44% said they always read the messages; the rest said they sometimes or often read the messages. Some 37% of the participants wanted text reminders twice a day, 20% once a day, 20% three to four times a week, and 17% said they preferred weekly text messages. Exactly 70% of respondents thought the text messages related to decreases in treatment time were the most effective, followed by motivational text messages and messages about oral hygiene, which were the least effective. The vast majority (97%) of patients found that text reminders helped them better understand the importance of brushing.

DISCUSSION

Text message reminders improve oral hygiene during orthodontic treatment. The three periodontal measures of the weekly text message group improved substantially, especially the BI. Compared to controls, hygiene improvements for orthodontic patients receiv-

Table 3. Bleeding Index (BI), Gingival Index (GI), and Plaque Index (PI) Correlations Between Initial (1) and Final (2) Measurements, with the Daily Group Above and the Weekly Group Below the Main Diagonal[a]

Correlations	BI_1	BI_2	GI_1	GI_2	PI_1	PI_2
BI_1		0.671**	0.417**	0.164	0.513**	0.360*
BI_2	0.697**		0.525**	0.474**	0.401**	0.444**
GI_1	0.489**	0.333*		0.461**	0.192	0.426**
GI_2	0.427**	0.418**	0.711**		0.285	0.411**
PI_1	0.547**	0.596**	0.385*	0.354*		0.738**
PI_2	0.581**	0.563**	0.424**	0.392**	0.731**	

[a] Significant at * $P < 0.01$ or ** $P < 0.001$.

ing weekly text message reminders have been reported.[10,11] They reported greater improvements than the present study, perhaps due to their longer durations (allowing more time to motivate the participants)[1] or when the studies were performed. The present study also differed from previous studies showing positive effects of text messaging in that the reminders were sent to the patients rather than parents. Parents are often more motivated than their children, especially when their children are already in treatment.[18] The long-term effects of text messages on oral hygiene remains to be established. Although further studies are needed, it is possible that the number and timing of text messages will need to be altered over time in order to maintain compliance. The Hawthorne effect (where individuals change their behavior while they are being observed) could have accounted for some of the hygiene improvements observed, as well as the differences between studies.

Text messaging might be expected to improve compliance of teenagers, who remain connected to mobile media at various locations and at all times.[9] A total of 88% of teens have access to cellular phones and 91% of those use text messages on a daily basis.[19] The average adolescent sends 100 texts per day;[9,19] the average duration of smartphone usage is 4.65 hours per day.[20,21] The impact of cellular phone usage and changing communication trends in adolescents make text message reminders an effective way to influence behavior. Daily messages make up 36% of all automated messaging frequencies.[22] Communications between adolescents is growing increasingly immediate and brief, trending toward more frequent communication.[23,24]

Frequency of text messages had a positive effect on compliance. Patients in the present study receiving automated messages daily had greater improvement in oral hygiene, with more substantial decreases in the BI, PI, and GI than the weekly group. Based on Cohen's D statistics, the experimental effect on the BI was large, while the effects on the PI and GI were medium. No other orthodontic study has compared weekly and daily

text messages. Daily text message reminders have been reported to increase compliance in the health care setting.[22] Daily text messaging is a constant reminder that the doctor is involved in the treatment. Increasing the frequency of text messages improves doctor-patient relationships and compliance with oral hygiene by increasing communication.[3,25,26] Adolescents need additional motivation to be compliant with treatment and constant text message reminders are one method to improve compliance.[10]

The medical literature has also shown that increasing the frequency of automated messages increased compliance.[12–15] A recent meta-analysis showed that patients receiving multiple text messages improved appointment attendance by 25%, compared to a 6% improvement by those who were sent just one reminder.[14] Multiple text reminders also improved adherence in pediatric cataract treatment[15] and exercise instructions.[13] Importantly, most of the medical studies were short term, making it difficult to extrapolate the longer term effects of more frequent messaging.

There appeared to be no sex differences in oral hygiene during orthodontic treatment. Although males had higher scores initially, differences in the present study were inconsistent and less than 2%. Other studies evaluating the oral hygiene of patients in fixed orthodontic appliances have also found no sex differences.[10,11,17] In contrast, female adolescents not in orthodontic appliances had better oral hygiene habits than males, showed more interest in oral health, and were more likely to perceive their own oral health to be good than males.[27–29] This suggests that fixed orthodontic appliances had an equalizing effect, with male and females worsening oral hygiene to the same level.

CONCLUSIONS

- Text messaging is an effective and simple way to improve oral hygiene in the adolescent patient while in fixed orthodontic appliances.
- Daily text messages were more effective at improving oral hygiene than weekly text messages.
- There were no sex differences in changes of oral hygiene that occur during orthodontic treatment.

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